Saudi Journal of Biological Sciences (2016) 23, 319–326

King Saud University

Saudi Journal of Biological Sciences

www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Socio-economic factors affecting the conservation of natural woodlands in Central Riyadh Area – Saudi Arabia

Faisal Sultan Al-Subaiee

Department of Agricultural Extension and Rural Society, College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

Received 9 December 2014; revised 19 February 2015; accepted 26 February 2015
Available online 10 March 2015

KEYWORDS

Natural resources;
Agricultural extension;
Woodland conservations;
Environmental education programs;
Capacity building;
Energy sources

Abstract This study aimed to identify some socioeconomic factors affecting local people in central Riyadh area for the utilization of wood and other energy sources in cooking and heating in order to develop some recommendations for conserving woodlands. The study results revealed that gas is the most common energy source used for cooking with a mean usage level of 2.79 (SD = 0.58). On the other hand, wood ranked first for heating with the highest mean, usage level of 1.90 (SD = 1.06). However, electricity and gas as sources of energy for heating ranked second and third with mean usage level of 1.81 and 0.80 respectively. The study revealed that local people with the university education were significantly making higher use of electricity for both cooking and heating and those with no formal education ranked the highest on wood use for both cooking and heating. In addition, those living in traditional houses significantly used more wood for cooking than those living in villas and apartments. Also, local people with high income levels significantly were using more electricity for heating than others. The study recommended conducting extension and environmental awareness raising programs to enhance local residents' adoption of wood substitutes, promoting employment opportunities for unemployed locals, and subsidizing prices of alternative energy sources.

1. Introduction

Forests are limited and depleting natural resources in Saudi Arabia and their growth, regeneration, and reforestation are expensive. Woodlands in Riyadh area cover about 290,000 ha and with the dominant tree species like *Acacia* spp., *Tamarix* spp., and *Haloxylon persicum* (Ministry of Agriculture, 2002; Badai and Aldawoud, 2004). Several factors like the excessive removal and extensive use of timber as

E-mail address: subaiee@ksu.edu.sa

Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.sjbs.2015.02.017

firewood and conversion of forests to agricultural lands or residential areas and overgrazing threaten the woodlands in Riyadh (El-Juhany, 2009; Ministry of Economy and Planning, 2005). The 9th Saudi development plan focuses on maintaining ecological balance in the Kingdom by offsetting the presently prevalent challenges. The plan stressed upon combating desertification by conserving and developing pastures and adopting sustainable management and development plans for rangelands and forests (Ministry of Economy and Planning, 2010). Moreover, in Saudi Arabia, the high demand for firewood has caused high pressure on the existing vegetation cover and consequently has reduced some plant species density and frequency such as *Acacia tortilis*, which is the most preferred as firewood in most parts of the country (Al-Abdulkader et al., 2009).

Despite the presence of other alternatives, such as electricity and liquefied petroleum gas (LPG), firewood remains to be one of the important sources of energy for heating and cooking in the rural areas especially in developing countries. The continuous usage of firewood could be because it is easy to store, less expensive to purchase and readily available throughout the year (Cecelski et al., 1979; Heltberg et al., 2000; Madubansi and Shackleton, 2007; Sebokah, 2009). However, LPG is extensively used for cooking in developing countries and has emerged as the most common source of energy due to its qualities like easy logistic and storage (IEA, 2006).

The socio-economic status of local community is known to have significant influence on determining the types of activities they are engaged in, as well as the impact on different types of interactions toward their natural resources. Understanding the social factors affecting people usage of natural resources remains an essential element to conserve natural resources (Olawoye, 1996). In addition, knowing more about local people usage of forests is an extremely important factor that could enhance planning of land use and minimize the conflict with them (Meijaard et al., 2013). Similarly Koenig et al. (2011) mentioned that the socio-economic features of masses living in the vicinity of nearby forests determined the type and quantity of harvesting timber in Central Arnhem Land, Australia. Bogale (2011) found that the age factor affected the respondent choice to pay for forest use rights in Ethiopia. The older residents living near the adjacent forests were significantly willing to pay for the forest use rights more than younger ones. Also, people with higher education level and training, and bigger family size exhibited greater willingness to pay for forest use rights. However, the household income and distance to forest area revealed a negative relationship with the respondents' willingness to pay for forest use rights. Rodrigues et al. (2011) maintained that people usage and access to the forest were among the important factors affecting their attitudes toward forests.

In many developing countries, mostly forestlands are owned by the governments and by exercising the customary laws; they allow the private investors, political elites and public projects to use the state-owned forestlands (Cleaver and Schrieber, 1990). This system of land tenure is closely related to the social stratification structure in a community (Olawoye, 1993). Emerton (1999) noted that local communities in Zambia have a large dependence on forest management programs and policies that promote or restrict the use of forests. This is critical to the poorest households to realize benefits and services from the local forests. While the richer households account for a bigger proportion of the harvested forest products, the poorest households are the worst victims of forest degradation or policies that control use without providing sufficient alternative income sources. A study conducted by Lundgren and Lundgren (1983) revealed that socio-economic constraints like: development program for the villages, increase in population and rapid enhancement in cultivation of land for agricultural purposes resulted in deforestation and disturbed forest management in Tanzania.

Agricultural extension programs do play the significant roles in changing the human behaviors (Van den Ban and Hawkins, 1996). Researchers like Madumere (2000) and Agbogidi and Ofuoku (2005) also believe that effective utilization of agricultural extension education programs can certainly help in raising awareness among the people on environmental issues and such initiatives are of paramount importance toward sustainable use and management of natural resources such as natural forestlands.

The purpose of this research is to determine respondents' usage levels of wood and other suitable alternative energy sources for cooking and heating and explore the socio-economic factors affecting their usage levels and consequently conservation of natural woodlands in the central area of Riyadh, Kingdom of Saudi Arabia. The study findings would contribute to develop appropriate extension education programs and recommend suitable policies to increase the local people using rate of energy sources other than wood in order to conserve the limited natural woodlands in the area.

2. Objectives of the study

In general, the purpose of this research study is to provide better understanding of the socio-economic factors influencing natural woodland conservation in the central area of Riyadh, Kingdom of Saudi Arabia. This will be achieved through determining the respondents' usage levels of wood and other alternative energy sources in cooking and heating.

The precise objectives of the study are to:

1. Assess the respondents' usage of wood and other alternative energy sources in cooking and heating.
2. Determine some of the socio-economic and demographic characteristics of the respondents.
3. Explore the differences between the respondents' usage levels of wood and other alternative energy sources in cooking and heating based on some of their socioeconomic and demographic characteristics.

3. Methods and procedures

Central Riyadh administrative area in this study includes Durmaa, Shagra, Thadig, Huraimila, and Muzahimia governorates, comprising an area of about 16830 km^2, and with the population of 88024 (Emirate of Riyadh, 2013). Agriculture and trading are the most important economic activities of the locals. This study was conducted in communities around the important natural woodlands locations in these governorates. To establish the study sampling-frame, a list of the main locations of natural woodlands in these governorates was obtained from the Ministry

of Agriculture and six locations had been randomly selected from the list using the Random Number Generator program. Then the communities around the selected locations were identified. A sampling-frame including all the households in the designated villages and communities near the locations was established with the help of local Key Informants.

The total number of households in the study area was found to be 14670 and out of this, a simple random sample of 300 households (2% of the households) was selected by using the Random Number Generator Program. The data were collected by conducting personal interviews of the household heads by using a well-structured questionnaire. The questionnaire was designed, pre-tested and validated with the help of members specializing in forestry and social sciences from the departments of Agricultural Extension and Rural Society and Plant Production, College of Food and Agriculture Sciences, King Saud University, Saudi Arabia. Descriptive statistics (frequency distribution, mean and standard deviation), and Kruskal–Wallis tests were used to analyze the data. The study witnessed an over-whelming response rate of about 95%. Moreover, the data were also collected through focused group discussion sessions which were attended by 16 persons including representatives from the Ministry of Agriculture branch in the area, farmers and livestock owners. The sessions intended to solicit the participants' opinions about the residents' important uses of natural woodlands, investigate reasons for residents' preference for local wood, subsequent cutting of trees and enlist the suggestions for natural woodlands conservation.

Table 1 Socio-economic characteristics of the respondents (n = 285).

	Percent		Percent
Age		*Place of current residence*	
Less than 30	35.1	Urban	42.5
From 31 to 50	49.5	Village	52.3
From 51 and more	15.4	Nomad	5.3
Family size		*Type of housing*	
Less than 5	59.3	Villa	42.8
From 5 to 10	35.4	Apartment	16.5
From 11 to >	5.3	Traditional house	40.7
Occupation		*Monthly income*	
Government employees	71.6	Less than SR 3000	16.1
Employees in the private sector	4.2	3000 – less than SR 6000	39.6
Merchant	1.0	6000 – less than SR 9000	25.0
Middlemen	9.1	SR 9000 or more	19.3
Farmers	2.5	*Marital status*	
Unemployed	7.7	Married	75.4
Student	3.9	Single	24.6
Educational level			
Can read and write			9.8
Primary school			8.1
Intermediate school			16.8
High school			41.8
University			23.5

*SR = Saudi Riyals.

4. Results and discussion

4.1. Demographic characteristics of the respondents

Socio-economic characteristics such as age, education, place of current residence, occupation, marital status, income and number of family members, etc., are known to have impact and influence on the way of thinking, attitudes and perceptions and behavior of the people toward the adoption of innovations (Hassan et al., 2002; Hassan, 2008).

The findings of the study (Table 1) indicate that about half (49.5%) of the respondents were between the age of 31 and 50 years, while more than one third of the respondents (35.1%) were less than 30 years of age. The respondents who were more than 50 years of age represented only 15.4%. Slightly more than half (52.3%) of the respondents belong to the village communities and approximately more than one third (42.5%) of the respondents were identified as urban due to their current place of residence.

More than one-third (41.8%) of the respondents had received their high school education and less than one fourth (23.5%) of the respondents were holding university degrees. Only 16.8% of the respondents were with intermediate education. The respondents who had no formal education, but can read, and write and those with primary education were 9.8% and 8.1% respectively. The majority of the respondents (71.6%) were the government employees. The respondents who reported their occupation as middlemen, employees in the private sector and students were 9.1%, 4.2% and 3.9% respectively. Only 1.0% of the respondents reported their occupation as merchants.

The monthly incomes of more than one third (39.6%) of the respondents ranged from SR 3000 to 6000 whereas about one fourth (25.0%) respondents were making SR 6000–9000 on a monthly basis. About 16.1% of the respondents were earning less than SR 3000 per month. The results also revealed that about 75.4% of the respondents were married and some 24.6% of the respondents identified themselves as singles.

Approximately 59.3% of the respondents had the families with less than five members and the family size of slightly more than one third (35.4%) of the respondents comprised only 5–10 members. Only 5.3% of the respondents were having more than 11 members in their families. Just close to two-fourth of the respondents (42.8%) and (40.7%) stated that they live in villas and traditional houses respectively, while only 16.5% of the respondents were living in the apartments. These variations in the socio-economic characteristics of local dwellers could influence their usage level of woodlands and their needs for extension education programs (Van den Ban and Hawkins, 1996; Bogale, 2011; Koenig et al., 2011; Rodrigues et al., 2011).

4.2. Usage level of energy sources in cooking and heating

The means and the standard deviations of the usage level of energy for different sources in cooking and heating on a four point scale (0 – not used; 1 – limited use; 2 – average use; 3 – high level use), are presented in Table 2. The overall mean values of the respondents' usage level for all the energy sources were 0.88 (SD = 0.53) and 0.76 (SD = 0.53) for cooking and heating respectively. The mean score of the respondent's usage of the different energy sources in cooking ranged from 2.79 (almost high use level) to 0.46 (ranging from not used to

Table 2 Usage level of energy sources in cooking and heating (n = 285).

Energy source	%					Mean	Std. deviation
	Not used	Limited	Average	High	Missing		
	Usage level of energy sources in cooking						
Gas	1.1	4.9	7.7	84.9	1.4	2.79	0.58
Electricity	37.9	38.6	11.2	9.1	3.2	0.91	0.94
Wood	40.0	42.5	13.7	0.7	3.1	0.74	0.72
Agricultural residues	46.7	48.4	0.7	–	4.2	0.52	0.51
Kerosene	48.4	46.3	0.7	–	4.6	0.50	0.52
Pressurized charcoal	49.1	46.0	1.1	–	3.8	0.50	0.52
Biogas	50.9	44.6	0.4	0.4	3.7	0.48	0.53
Gel fuel	50.9	44.9	0.4	–	3.8	0.47	0.51
Solar energy	51.9	44.6	–	–	3.5	0.46	0.50
	Usage level of energy sources in heating						
Wood	15.8	13.7	33.3	35.1	2.1	1.90	1.06
Electricity	3.5	34.0	37.5	22.8	2.2	1.81	0.83
Gas	30.2	58.2	3.9	3.5	4.2	0.80	0.68
Agricultural residues	44.2	48.1	2.8	0.4	4.5	0.57	0.57
Kerosene	46.0	46.3	3.5	–	4.2	0.56	0.57
Pressurized charcoal	48.8	45.6	1.1	–	4.5	0.50	0.52
Solar energy	49.8	45.3	0.7	–	4.2	0.49	0.52
Gel fuel	50.9	44.6	–	–	4.5	0.47	0.50
Biogas	50.5	43.5	0.4	–	5.6	0.47	0.51

0 – not used; 1 – limited; 2 – average; 3 – high.

limited used level) and ranged from 1.90 (almost average used level) to 0.47 (ranging from not used to limited used level) in heating. These findings do indicate that the participants used different volumes of energy from the different sources for cooking and heating. They also exhibited that locals were using more energy sources in cooking than in heating. This result is normal since the demand on heating is during winter only while the demand on energy sources for cooking is across the year.

To explore the impact of local people energy consumption on natural woodland conservation, the percentages of respondents using different levels of energy sources were calculated to determine which source of energy they used the most for cooking and heating and how that will impact on natural woodlands. The study (Table 2) revealed that gas was the most commonly used energy source for cooking with a mean level of usage of 2.79 (SD = 0.58) attaining the highest usage level on the four point scale. Moreover, some 84.9% of the respondents reported that they used gas at a high level for cooking purposes. Whereas the electricity and wood ranked the second and third as the sources of energy used for cooking with the 0.94 and 0.74 mean usage level respectively.

On the other hand, wood as a source of energy for heating ranked first by attaining the highest usage level with the mean of 1.90 (SD = 1.06) (almost average usage level on the fourth point scale). More than two third (68.4%) respondents reported that they use wood for heating at an average and the high use level. The findings of the survey study are consistent, realized through the focused group discussion sessions. Both the components of the study revealed that locals primarily use natural woodland for getting wood for heating purposes. Participants in the focused group discussion sessions revealed that the residents living in the neighborhood prefer native wood because of its appealing qualities like: that produces little smoke, smells good, gets ignition quickly, generates heat with higher intensity and is easily available at the reasonable prices. In addition, local people culturally feel a sort of satisfaction and view the use of natural wood as a sign of generosity and hospitality. Also, the high demand on wood for heating is consistent with the findings of the several studies reporting the locals as the extensive users of woodlands extracting high volumes of firewood (El-Juhany, 2009; Ministry of Economy and Planning, 2005; Al-Abdulkader et al., 2009).

The findings of the study indicate that wood remains the prime source of energy used for heating and cooking purposes, posing a very serious threat to natural woodland conservation. The fact was also confirmed by the participants of the focused groups, indicating that the local people meet their fuelwood needs from the nearby natural woodlands without obtaining required permits from any authority or through buying it from other illegal wood harvesters. The participants also mentioned that illegal harvesting and indiscriminate removal of trees pose a threat to the natural woodlands to the extent that some of the preferred tree species are endangered. To overcome this, the participants of the focused groups in the sessions held suggested the subsidizing of the prices of the alternative sources of energy such as electricity and gas, importing of wood with the similar qualities comparable with the local species and the launching of extension educational programs to elevate and enhance the awareness levels of the local peoples on the importance of woodlands and their conservation.

On the other hand, electricity and gas ranked second and third as sources of energy for heating with the mean usage levels of 1.81 and 0.80 respectively. These findings of the study are consistent with those reported by Matsika et al. (2013). They also indicated that electricity and wood are the dominant sources of energy used by most of the households for cooking and heating purposes. Also, Vicedo-Cabrera et al. (2012) mentioned that respondents attach the greatest preference to gas in cooking but prefer electricity in heating.

One of the potential sources of energy if exploited properly that could lessen the pressure on forests is agricultural residues. Such sources if consumed as the fuel wood can certainly help conserving natural woodlands. However, the findings revealed that this energy source has very limited level of use in the study area with a mean level of usage of 0.52 and 0.51 in cooking and heating respectively. In addition, 46.7% and 44.2% of the respondents indicated that they were not using agricultural residues as a source of energy for cooking and heating respectively. Moreover, about half of the respondents (48.4% and 48.1%) reported that they used agricultural residues on a limited scale as a source of energy for heating. Low use of agricultural residues as an alternative source of energy for fuel wood for different purposes also represents one of the challenges that hinder natural woodland conservation.

Less than half of the respondents (46.3% and 46.0%) used kerosene oil and pressurized charcoal on a small scale in cooking with mean value of 0.50 (SD = 0.52); while about same number of respondents (46.3% and 45.6%) reported the use of kerosene oil and pressurized charcoal for heating with mean value of 0.56 (SD = 0.57) and 0.50 (SD = 0.52) respectively. These findings of studies conducted by Hosier and Dowd (1987), Bruce et al. (2000) and UNDP (2009) indicated that the consumers showed greater use of kerosene over charcoal for their cooking and heating and are in line with the outcomes of the present study. Similarly a report produced by REN21 (2013) also indicated that only 4% and 34% of the rural and urban households used charcoal as energy source respectively.

The least used three energy sources for cooking were biogas, gel fuel, and solar energy (with a mean level of use ranging from 0.46 to 0.48 and for heating purposes solar energy, gel fuel and biogas (the mean level of use ranged from 0.47 to 0.49) were among the least under use. Furthermore, the study showed that more than half of the respondents were not using these energy sources in cooking and heating. The findings of the study are in line with Ruane et al. (2010) who reported that less than 1% of the households in China were using biogas for cooking and heating in the year 2005. The low usage level of biogas may be attributed to technical and cultural factors and the high capital investment needed at the beginning (Mwakaje, 2008; Mshandete and Parawira, 2009; Mkiramweni and Mshoro, 2010). Therefore, the most possible substitutes for wood as a source of energy are gas and electricity for cooking and heating respectively. This result could be used in planning extension education programs as the current adoption levels of gas and electricity are quite encouraging, therefore it would be relatively easy to enhance and promote their usage than other energy sources.

The study demonstrated the need for reducing the use of natural wood as a source of energy by the locals in order to conserve natural woodlands in the study areas. The use of wood as a source of energy especially for heating is culturally attached with the native heritage and locals' attitudes. Therefore, the initiation of the extension education programs seems an essential measure to enhance locals' knowledge levels on using the substitutes for natural wood for heating and cooking. Such educational programs also need to focus on changing locals' attitudes and behaviors toward conserving natural woodlands. Also, the Ministry of Agriculture needs to encourage importing the kind of wood bearing same qualities of the native wood to satisfy local's requirements (such as *A. tortilis*). In addition, still a vibrant woodland conservation policy needs to be formulated with the participation of all the stakeholders from academic institutes, private sector, local communities, and the government departments.

4.3. Differences between the respondents' usage levels of energy sources and some of their socio-economic and demographic characteristics

4.3.1. Education

Chi-square test (Table 3) was used to depict the differences between the respondents' educational level and their usage level of electricity, gas and wood as sources of energy in cooking and heating. The study revealed statistically significant differences between the respondents' education levels and their use of electricity and wood for cooking and heating (p = 0.000, 0.008, 0.001, 0.002 at the 0.05 level of significance respectively). The respondents with the university education ranked the highest for using electricity for both cooking and heating and those with no formal education ranked the highest on wood use scale for both cooking and heating.

These findings are in line with Tortop (2012) who found that education has a great impact on creating awareness regarding the importance of using wood alternative sources of energy in cooking and heating. In addition, Link et al. (2012) maintain that education provides information on the use of alternate energy sources. Based on these findings, extension education programs need to attach greater importance and higher priority to the less educated people on the conservation of woodlands and wood.

However, in case of gas statistically significant differences between the respondents' education levels and use of gas as a source of energy for heating (p = 0.028) at (0.05) level of significance were observed. The respondents with no formal education ranked the highest on the gas usage scale for heating, but the difference does not exist in the case of using gas as a source of energy for cooking. Gas is the most extensively used energy source for cooking by the locals (Table 2). Educational level could be the possible reason for its usage level.

4.3.2. Housing

The findings of the present study showed no significant difference between respondents living in villas, apartments and traditional houses regarding their use of electricity as a source of energy for cooking (Table 4). On the other hand, a statistically significant difference (p = 0.002 at 0.05 level of significance) was observed between the respondents living in the different types of housing and their use of wood for cooking. The respondents living in the traditional houses ranked the highest whereas those living in the villas ranked the lowest for using wood for cooking.

However, as depicted in Table 4, statistically significant differences in the level of use of electricity, gas and wood as sources of energy for heating (p = 0.000) at (0.05) level of significance were noticed. The respondents living in villas ranked the highest for using electricity as the energy source for heating purposes, whereas those living in the traditional houses ranked the lowest. On the other hand, respondents living in the traditional houses ranked the highest in using both gas and wood as the sources of energy for heating, while those living in apartments and villas ranked the lowest in using gas and wood as energy sources for heating. Based on the finding, woodland

Table 3 Kruskal–Wallis test for differences in respondents' usage of energy sources based on their education.

Energy source	Education	Cooking				Heating			
		N	Mean Rank	Chi-square	Sig.*	*N*	Mean Rank	Chi-square	Sig.*
Electricity	Can read and write	20	128.35	26.84	0.000	20	125.35	19.92	0.001
	Primary school	23	102.37			22	115.50		
	Intermediate school	46	107.85			47	141.69		
	High school	117	133.78			117	121.81		
	University	63	171.11			66	169.22		
Gas	Can read and write	21	143.05	3.81	0.432	21	172.07	10.90	0.028
	Primary school	22	137.84			23	146.80		
	Intermediate school	47	148.41			46	124.41		
	High school	118	132.99			116	136.28		
	University	66	135.91			62	121.37		
Wood	Can read and write	21	157.38	13.73	0.008	21	173.43	16.99	0.002
	Primary school	23	109.76			23	145.04		
	Intermediate school	47	141.31			48	125.77		
	High school	115	146.36			115	149.50		
	University	64	113.79			67	111.46		

* Sig. at 0.05 level.

Table 4 Kruskal–Wallis test for differences in respondents' usage of energy sources based on their type of housing.

		Cooking				Heating			
		N	Mean Rank	Chi-square	Sig.*	*N*	Mean Rank	Chi-square	Sig.*
Electricity	Villa	116	142.59	2.73	0.255	119	169.72	59.53	0.000
	Apartment	45	132.04			46	148.76		
	Traditional house	107	126.76			107	94.29		
Gas	Villa	121	137.65	4.16	0.125	117	121.96	21.15	0.000
	Apartment	45	125.23			43	110.92		
	Traditional house	108	142.44			107	156.44		
Wood	Villa	117	121.00	12.31	0.002	118	101.40	82.91	0.000
	Apartment	45	127.12			47	108.91		
	Traditional house	107	153.62			108	188.12		

* Sig. at 0.05 level.

conservation and wood alternative sources of energy, first of all extension education programs could target local people living in the traditional houses as they use wood as the energy sources more than other groups.

4.3.3. Income

The study revealed that no significant differences between respondents with different income levels in their usage level of gas and wood as sources of energy for both cooking and heating were observed. The results are similar to those obtained by Ouedraogo (2006) as he mentioned that families' usage of wood is not significantly related to the household income. However, statistically significant differences between the respondents' income and their level of use of electricity as a source of energy for heating ($p = 0.00$ at 0.05 level of significance) were noticed (Table 5). This finding showed that the local people with higher income use more electricity for heating than people with lower incomes. The participants of focused groups also did confirm the fact in the discussion sessions held at occasions, suggesting the subsidizing of the prices of wood substitutes such as electricity to encourage its use as the source of energy by the masses residing in the nearby forests, particularly natives with low incomes. The study results are also consistent with the findings of Alam et al. (1998), Campbell et al. (2003), Davis (1998) and Ouedraogo (2006) as they opined that income is the major and the most important determinant of usage of some energy sources of the households. They also observed that as the income levels of the household increased, firewood utilization rate decreased

Table 5 Kruskal–Wallis test for differences in respondents' usage of electricity as an energy source for heating based on their income.

Energy source	Income level	N	Mean Rank	Chi-square	Sig.*
Electricity	Less than SR 3000	17	108.12	21.58	0.00
	3000 – less than SR 6000	111	115.97		
	6000 – less than SR 9000	71	117.44		
	SR 9000 or more	52	164.95		

* Sig. at 0.05 level.

Table 6 Kruskal–Wallis test for differences in respondents' usage of energy sources based on their current place of residence.

Energy source	Location	Cooking				Heating			
		N	Mean Rank	Chi-square	Sig.*	*N*	Mean Rank	Chi-square	Sig.*
Electricity	Urban	113	142.73	6.14	0.046	118	163.71	33.78	0.000
	Village	149	125.81			148	111.57		
	Nomad	2	53.00			2	107.75		
Gas	Urban	120	127.99	6.98	0.031	113	106.59	30.46	0.000
	Village	147	142.22			147	151.71		
	Nomad	3	106.83			3	123.33		
Wood	Urban	115	115.77	13.51	0.001	117	101.47	43.04	0.000
	Village	147	145.27			149	161.55		
	Nomad	3	192.50			3	123.83		

* Sig. at 0.05 level.

and in response the usage of electricity increased ultimately. These results are consistent with the studies conducted by Bluffstone (1995), Campbell et al. (2003) and Link et al. (2012) as they discussed that it may be due to the increase in income that enables people to switch to commercial energy sources. To encourage locals using electricity as a source of energy for heating rather than wood, a price subsidy policy could lessen the pressure on the local woodlands.

4.3.4. Place of current residence

Chi-Square tests (Table 6) showed that the respondents' place of current residence has a statistically significant influence on their usage level of electricity, gas and wood as sources of energy for cooking and heating (p = 0.046, 0.031, 0.01, 0.000 at 0.05 level of significance respectively). The study revealed that the highest level of usage of electricity for both the cooking and heating purposes was noted with the urban respondents. However, respondents living in the villages were using the highest level of gas for cooking and heating. The nomads were using more wood in cooking while the respondents living in the villages showed the highest level of wood use for the heating purposes. Participants of the focused groups identified the masses living in the vicinity of the neighboring forests i.e. the villagers and nomads as the prime illegal tree harvesters.

These results are consistent with the findings of the study conducted by Vicedo-Cabrera et al. (2012). They are of the opinion that geographic area is an important factor that influences the usage level of energy sources. Based on the findings of a report REN21 (2013), it was concluded that demands for the different energy sources between urban and rural people happened to be different. For instance, as observed in the present study some 94% of the rural families depended on wood or crop residues as the energy source while in urban areas about 41% families were using wood as the primary source of energy. Present study suggested that the extension education programs primarily need to focus on and attach greater importance to the locals living in the rural areas in order to conserve woodlands and help them substitute wood with the other suitable alternative sources of energy.

5. Conclusions and recommendations

The findings of the study revealed that natural wood is the main source (with the highest usage mean) of energy for heating for the locals in the study area. The forests in the Kingdom of Saudi Arabia are depleting and seem under severe stress due to natural, climatic and human factors. Heavy and illegal extraction and high usage of wood by the locals appear to be the main challenges and prime threats to the natural woodland conservation initiatives. Analysis of the social survey, focused group discussions and the gathered data unveiled that respondents residing in the villages and with no formal education and living in the traditional houses had the highest usage of wood as the source of energy for heating. The study also indicated that use of wood from the nearby woodland is associated with some socioeconomic and cultural factors such as the belief that it is of high quality with good smell and low price; and easily accessible. Moreover, participants in the focused group discussion sessions reported that wood cutting on the commercial basis is excessively practiced by unemployed locals to earn income.

There is a pressing need for comprehensive policies and regulations that acknowledge the crucial role and high value of forests and natural ecosystems so as to enhance natural woodland conservation. The study recommended the execution of extension education and awareness raising programs on forests and environment to ensure and enhance locals' adoption of wood substitutes, promoting employment opportunities for the unemployed locals, and subsidizing prices of alternative energy sources.

Acknowledgment

This project was supported by NSTIP strategic technologies program number (ENV-514-02-08) in the Kingdom of Saudi Arabia.

References

Alam, M., Sathaye, J., Barnes, D., 1998. Urban household energy use in India: efficiency and policy implications. Energy Policy 26, 885–891.

Al-Abdulkader, A.M., Shanavaskhan, A.E., Al-Khalifah, N.S., Nasrounm, T.H., 2009. The economic feasibility of firewood plantation enterprises in Saudi Arabia. Arab Gulf J. Sci. Res. 27, 1–6.

Agbogidi, O.M., Ofuoku, A.U., 2005. State of forestry research and education in Nigeria. In: Popoola, L., Mfon, P., Oni, P.I. (Eds.), Proc. 30th Annu. Conf. FAN held in Kaduna, Kaduna State between 7th and 11th of November 2005, pp. 484–490.

Badai, K.H., Aldawoud, A.N., 2004. The Natural Forests in Saudi Arabia. Samha Press, Riyadh, Saudi Arabia.

Bluffstone, R.A., 1995. The effect of labor market performance on deforestation in developing countries under open access: an example from rural Nepal. J. Environ. Econ. Manage. 29, 42–63.

Bogale, A., 2011. Valuing natural forest resources: an application of contingent valuation method on Adaba-Dodola Forest Priority Area, Bale Mountains, Ethiopia. J. Sustainable For. 30, 518–542.

Bruce, N., Perez-Padilla, R., Albalak, R., 2000. Indoor air pollution in developing countries: a major environmental and public health challenge. Bull. World Health Organ. 78, 1078–1092.

Campbell, B.M., Vermeulen, S.J., Mangono, J.J., Abugu, R., 2003. The energy transition in action: urban domestic fuel choices in a changing Zimbabwe. Energy Policy 31, 553–562.

Cecelski, E., Dunkerley, J., Ramsay, W., 1979. Household energy and the poor in the third world. In: Resources for the Future, Washington DC, USA.

Cleaver, K., Schrieber, G., 1990. The Population, Agriculture and Environment Nexus in Sub-Saharan Africa. The World Bank, Washington, DC, USA.

Davis, M., 1998. Rural household energy consumption: the effects of access to electricity – evidence from South Africa. Energy Policy 26, 207–217.

El-Juhany, L.I., 2009. Forestland degradation and potential rehabilitation in Southwest Saudi Arabia. Aust. J. Basic Appl. Sci. 3, 2677–2696.

Emerton, L., 1999. Using Economics for Biodiversity Strategies and Action Plans in Eastern Africa. IUCN Eastern Africa Regional Office, Nairobi, Kenya.

Emirate of Riyadh, 2013. Ministry of Interior, Kingdom of Saudi Arabia. Available at: <http://www.moi.gov.sa/wps/portal/riyadh/!ut/p/b1/04_Sj7Q0MLcwtDA1MtGP0I_KSyzLTE8syczPS8wB8aPM4t39woKN3T2MDQ08LcwNPAMDvVw8jLwM_c2N9IMTi_RzoxwVAVQ43qw!/?WCM_GLOBAL_CONTEXT=/wps/wcm/connect/riyadh/riyadh+ar/governorates/&WCM_Parent_Path=/riyadh/riyadh+ar/governorates> (accessed March 12, 2013).

Hassan, M.Z.Y., 2008. Analysis of the Obstacles to Gender Mainstreaming in Agricultural Extension in the Punjab Pakistan: A Case Study of District Muzaffargarh. Available at: <http://prr.hec.gov.pk/thesis/2327.pdf> (accessed March 12, 2013).

Hassan, M.Z.Y., Siddiqui, B.N., Irshad, M.N., 2002. Effect of socio-economic aspects of mango growers on the adoption of recommended horticultural practices. Pak. J. Agric. Sci. 39, 20–21.

Heltberg, R., Arndt, T.C., Sekhar, N.U., 2000. Fuel wood consumption and forest degradation: a household model for domestic energy substitution in rural India. Land Econ. 76, 213–232.

Hosier, R.H., Dowd, J., 1987. Household fuel choice in Zimbabwe: an empirical test of the energy ladder hypothesis. Resour. Energy 9, 347–361.

IEA, 2006. Energy for Cooking in Developing Countries. World Energy Outlook, pp. 419–446 (Chapter 15).

Koenig, J., Altman, J., Griffiths, A.D., 2011. Artists as harvesters: natural resource use by indigenous wood carvers in Central Arnhem Land, Australia. Hum. Ecol. 39, 407–419.

Link, F.C., Axinn, W.G., Ghimire, D.J., 2012. Household energy consumption: community context and the fuel wood transition. Soc. Sci. Res. 41, 598–611.

Lundgren, B.O., Lundgren, L., 1983. Socio-economic Effects and Constraints in Forest Management: Tanzania, ICRAF Reprint No. 2, International Council for Research in Agroforestry, Nairobi.

Madubansi, M., Shackleton, C.M., 2007. Changes in fuelwood use and selection following electrification in the Bushbuckridge Lowveld, South Africa. J. Environ. Manage. 83, 416–426.

Madumere, A.J., 2000. Environmental programme as indispensable tool for enriching public environmental education in Nigeria. In: Akale, M.A.G., (Ed.), Proc. 41st Annu. Conf. Sci. Teach. Assoc. Nigeria (STAN) held on Awka, Anambra State between 21st and 26th of August, 2000. pp. 188–190.

Matsika, R., Erasmus, N.F.B., Twine, C.W., 2013. Double jeopardy: the dichotomy of fuel wood use in rural South Africa. Energy Policy 52, 716–725.

Meijaard, E., Abram, N.K., Wells, J.A., Pellier, A.S., Ancrenaz, M., et al, 2013. People's perceptions about the importance of forests on Borneo. PLoS ONE 8 (9), e73008. http://dx.doi.org/10.1371/journal.pone.0073008.

Ministry of Agriculture, 2002. Forestry Strategy and Work Plan in Saudi Arabia. Ministry of Agriculture, Riyadh, Saudi Arabia.

Ministry of Economy and Planning, 2005. The Eighth Development Plan. Ministry of Economy and Planning, Riyadh, Saudi Arabia.

Ministry of Economy and Planning, 2010. Kingdom of Saudi Arabia. The Ninth Development Plan 1431-1435 H. Available at: <http://www.mep.gov.sa/> (accessed February 01, 2012).

Mkiramweni, L.L.N., Mshoro, I.B., 2010. Estimating the potential for biogas production and applications in Morogoro region, Tanzania. Energy Environ. 21, 1357–1367.

Mshandete, A.M., Parawira, W., 2009. Biogas technology research in selected Sub-Saharan African countries – a review. Afr. J. Biotechnol. 8, 116–125.

Mwakaje, A.G., 2008. Dairy farming and biogas use in Rungwe District, South-West Tanzania: a study of opportunities and constraints. Renewable Sustainable Energy Rev. 12, 2240–2252.

Olawoye, J.E., 1993. Training Manual for Sensitivity to Social Issues in Forestry and Natural Resources Research Development Strategies. Prepared for FORMECU.

Olawoye, J.E., 1996. Sociological issues in sustainable forest management. Ghana J. For. 3, 13–18.

Ouedraogo, B., 2006. Household energy preferences for cooking in urban Ouagadougou, Burkina Faso. Energy Policy 34, 3787–3795.

REN21, 2013. Renewables 2013 Global Status Report. REN21 Secretariat, Paris, ISBN: 978-3-9815934-0-2. Available at: <http://www.ren21.net/portals/0/documents/resources/gsr/2013/gsr2013_lowres.pdf> (accessed Jan 14, 2014).

Rodrigues, R.R., Gandolfi, S., Nave, A.G., Aronson, J., Barreto, T.E., Vidal, C.Y., Brancalion, P.H.S., 2011. Large-scale ecological restoration of high diversity tropical forests in SE Brazil. For. Ecol. Manage. 261, 1605–1613.

Ruane, J., Sonnino, A., Agostini, A., 2010. Bioenergy and the potential contribution of agricultural biotechnologies in developing countries. Biomass Bioenergy 34, 1427–1439.

Sebokah, Y., 2009. Charcoal production: opportunities and barriers for improving efficiency and sustainability. In: Bio-carbon Opportunities in Eastern and Southern Africa harnessing carbon finance to promote sustainable forestry, agroforestry and bio-energy. UNDP (United Nations Development Programme), New York, USA, pp. 102–126.

Tortop, H.S., 2012. Awareness and misconceptions of high school students about renewable energy resources and applications: Turkey case. Energy Educ. Sci. Technol. Part B: Soc. Educ. Stud. 4, 1829–1840.

UNDP, 2009. UNDP World Energy Assessment: Energy and the Challenge of Sustainability. United Nations Development Programs, New York, USA.

Van den Ban, A.W., Hawkins, H.S., 1996. Agricultural Extension, second ed. Blackwell Science Ltd., Cambridge, Massachusetts.

Vicedo-Cabrera, M.A., García-Marcos, L., Llopis-González, A., López-Silvarrey, A., Miner-Canflanca, I., Batlles-Garrido, J., Blanco-Quiros, A., Busquets-Monge, R.M., Díaz Vazquez, C., González-Díaz, C., Martínez-Gimeno, A., Guillén-Grima, F., Arnedo-Pena, A., Morales-Suárez, M., 2012. Atopic dermatitis and indoor use of energy sources in cooking and heating appliances. BMC Public Health 12, 890. Available at: <http://www.biomedcentral.com/1471-2458/12/890> (accessed 5 April, 2013).